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RESPECTING THE GEOLOGICAL RELATIONS AND
FOSSIL REMAINS OF THE SILURIAN IRON
ORES OF PICTOU, NOVA SCOTIA:

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NEW FACTS RESPECTING THE GEOLOGICAL RELATIONS AND FOSSIL REMAINS OF THE SILURIAN IRON ORES OF PICTOU, NOVA SCOTIA.

BY J. W. DAWSON, LL.D., F.R.S.

(Read before the Natural History Society of Montreal, April 5th, 1880.)

The subject of this paper has already been discussed by me in various previous publications; and most recently in a paper read at the Portland meeting of the Association for the Advancement of Science in 1874, and published in the Journal of this Society; and in the Supplement to the second edition of "Acadian Geology," 1878. In these publications I have described the general arrangement of the Rocks of the Cobequid Series in the rising grounds on both sides of the East Branch of the East River of Pictou, the superposition on these of Upper Silurian rocks holding bedded red hematite, and the occupation of the valley itself by a narrow band of Lower Carboniferous beds.

I may explain that the name "Cobequid group" was proposed in my Acadian Geology, 1868, for the series of schistose and crystalline rocks constituting the axis of the Cobequid hills, and extending eastward from these, with some partial interruption, through the hilly districts of southern Pictou. In the Cobequid hills, where these rocks are well exposed, they consist of two members: (1) an upper series of gray and dark slates and quartzites with a band of crystalline limestone and veins of iron ores; (2) a lower series consisting largely of felsite, porphyry and agglomerate. Both series are penetrated by dykes and masses of red syenite and dark-coloured diabase, the latter cutting also the overlying Silurian rocks. These last, as seen at Wentworth and New Annan, overlie unconformably the Cobequid group, and afford fossils characteristic elsewhere of the Upper Silurian system. The least antiquity that can be assigned to the Cobequid rocks is thus that of the Siluro-Cambrian; and by some, on the ground chiefly of mineral character, they have been regarded as Huronian. I have ventured to suggest, on the evi-

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dence of their relations to the Upper Silurian beds, and to the apparently older Cambrian series of the Atlantic coast, that they may be representatives of the Skiddaw and Borrowdale series of England, and of the Quebec group of the Lower St. Lawrence.

These rocks, in their extension into Pictou County, present characters not dissimilar from those seen in the Cobequids. On the high ground on the west side of the east branch of the East River, they consist of thick beds of gray and dark slate and quartzite, having a general strike of N. 20° to 30° W., and with very high dips to the S.W. They include a great vein of specular iron ore, associated with magnetite, ankerite, and limonite, of the same character with that so well known on the south side of the Cobequids in Londonderry.

The river valley, which not improbably occupies an ancient line of fracture, presents a narrow trough of Lower Carboniferous rocks, containing limestone and gypsum; and at the junction of these Carboniferous beds with the older rocks, on the east side of the river, there is a fissure vein, filled with Limonite, and in some places attaining to large dimensions.

The hills on the east side of the river consist largely of hard gray slates, micaceous slates, obscure diorites, agglomerate and felsite, with syenitic dykes and masses. They correspond very nearly in mineral character with the Lower Cobequid series, and though rudely parallel to the slates on the opposite side of the river, they have so suffered from fractures and unequal denudation that they present a very irregular surface, in the depressions of which are the Upper Silurian hematites and their associated beds; and these rocks also succeed those of the Cobequid series to the north-eastward, forming a long line of outcrop extending from the East River of Pictou towards Arisaig. Thus the general geological character of the region is similar to that of the Cobequid hills, though locally more irregular and with larger areas of Upper Silurian beds.

So far the structure of the district has been pretty well known for some time, but its somewhat complex details have been little worked out, except in connection with the tracing of the iron deposits, in which some explorations have been made, more especially by Dr. G. M. Dawson, Mr. Gilpin, and the writer. For several years the principal iron properties have been under the care of E. Gilpin, Esq., F.G.S., now Superintendent of Mines for Nova Scotia, and his surveys have thrown much light on the

distribution of the strata containing the bedded iron ores, indicating approximately the dimensions and direction of the troughs resting on the Cobequid series, and the distribution of those which flank that series on the north-east. More especially these researches have shewn that there are two distinct beds of iron ore, separated by a considerable thickness of slaty and quartzose strata,* and underlaid by slate, sandstone, and conglomerate or breccia, differing from those of the Cobequid series. I do not propose here to enter into the details of these observations, but merely to notice their relations to the palæontology of the district.

The fossils collected in the district were obviously referable to the "Arisaig series," ranging from the Clinton to the Lower Helderberg inclusive, but the new facts indicated in Mr. Gilpin's manuscript map, which he has kindly communicated to me, suggested more careful local comparisons; and as my collections, though extensive, had not been made with reference to the new details of distribution, I thought it desirable to supplement them with additional material. This was obtained by Mr. Donald Fraser of Springville, a well known explorer of these rocks, who by my request visited all the exposures of the iron ores, and collected the fossils found in the ore itself and the including beds, keeping the specimens from each locality separate. In this way a large number of additional specimens were obtained, forming a series of local collections representing the different ore horizons.

The general result of the study of these specimens is to show that both beds of iron ore are Upper Silurian, and approximately of Lower Helderberg age. As compared with the typical Arisaig series, as defined in Acadian geology, they represent the middle and upper part of that series.

The fossils referred to are unfortunately not always in the best state of preservation. They are contained in hard rock, from which they are extracted with difficulty, and are often best studied in the impressions left when they are weathered out. They are also not infrequently distorted. For these reasons it is not always possible to be certain as to their identification; and in cases of doubt I have given a reference to the known species which they most nearly resemble.

* In a work on the "Mines and Mineral Lands of Nova Scotia," received while this paper was in the press, Mr. Gilpin estimates the thickness of intervening beds at 700 feet.

In the lower bed of iron ore, as represented at the Webster and Blanchard locations, the following fossils have been recognized; though in these beds the fossils are neither so abundant nor so well preserved as in the upper beds. Those marked with an asterisk are found also at Arisaig.

- * *Stenopora* (*Chaetetes*) (allied to *S. fibrosa*).
- * *Crinoid* stems.
- * *Chonetes Novascotica*, Hall.
- * *C. tenuistriata*, Hall.
- * *Spirifer rugae-costa*, Hall.
- S.* — (a large species allied to *S. arenosa*.)
- * *Strophomena profunda*, Hall.
- * *S. rhomboidalis*, Wilek.
- * *Rhynchonella Saffordi*, Hall.
- R.* — (large species with about 20 prominent undivided ribs, very characteristic of some parts of the iron ore.)
- R.* allied to *R. nobilis*, Hall.
- Pentamerus* (allied to *P. pseudo-galeatus*).
- Stricklandinia Billingsi*, n. s. (see infra).
- Rensselaeria aquiradiata*, Conrad.
- * *Orthis testudinaria*, Dalman.
- Platyceras*, sp.
- Platystoma depressa*, Hall, or allied.
- * *Orthoceras*, annulated (allied to *O. ibex*).
- * *O. punctostriatum*, Dawson.
- * *Cornulites flexuosus*, Hall.
- * *Calymene Blumenbachii*, Brong.
- * *Homalonotus Dawsoni*, Hall.
- Homalonotus* (finely banded pygidium? n. s.)

These fossils are not numerous, but they present the same partly Clinton and partly Upper Helderberg facies seen in the middle portion of the Arisaig series.

At the Ross location, East River, at the Holmes location, west side of Sutherland's River, and at the east side of Sutherland's River, in outcrops believed to be those of the upper bed, the following species occur:—

- * *Stenopora* (allied to *S. fibrosa*).
- Syringopora*, sp.
- Cladopora* (slenderly branching species).
- * *Crania Acadiensis*, Hall.

- * *Spirifer subsulcatus*, Hall.
- * *Sp. rugae-costa*, Hall.
Sp. (large species similar to that in last list.)
- * *Chonetes Nova Scotica*, Hall.
- * *Strophomena rhomboidalis*, Wilck.
- * *S. Gilpini*, n. s. (see *infra*).
- * *Orthis testudinaria*, Dalman.
O. perelegans, Hall (or allied).
O. discus, Hall (or allied).
Strophodontu varistriata, Hall (or allied).
- * *Rhynchonella Saffordi*, Hall.
R. vellicata, Hall (or allied).
R. pyramidata, Hall (or allied).
- * *Atrypa reticularis*, Linn. (coarsely ribbed variety).
Stricklandinia Billingsi, n. s. (see *infra*).
Pentamerus sp.
Discina (smooth conical species like *D. oblong ita*, Portlock
(see *infra*)).
- * *Cytherodon sulcatus*, Billings.
- * *Megambonia cancellata*, Hall (see *infra*).
- * *M. striata*, Hall.
- * *Pteronitella curta*, Billings.
- * *P. oblonga*, Billings.
- * *P. venusta*, Billings (or allied).
Avicula textilis, Hall (or allied).
A., new species? (see *infra*).
- * *Clidophorus concentricus*, Hall.
- * *C. elongatus*? Hall.
- * *Grammysia remota*, Billings.
- * *Murchisonia Arisauigensis*, Hall.
- * *M. acicula*, Hall.
Platyostoma depressa, Hall (or allied).
Cyrtoceras subrectum, Hall.
Cyrtoceras, n. s. (see *infra*).
- * *Orthoceras punctostriatum*, Dawson.
- * *Cornulites flexuosus*, Hall.
C. n. s. (see *infra*).
- * *Homalonotus Dawsoni*.
H. (smooth pygidium, allied to *H. delphinocephalus*).
- * *Calymene Blumenbachii* (large and small varieties or sub-species).

Phacops caudatus (or allied).

Dalmania, allied to *D. micrurus*, Hall.

* *D. Logani*, Hall.

It will be seen that, while the majority of the species found in the lower bed occur also in the upper, the latter is much richer in species, and especially in those of the Upper Arisaig or Lower Helderberg proper. It is also remarkable for its much greater number of Lamellibranchiate shells and Trilobites. On the other hand it presents no points of resemblance with the Oriskany fossils which accompany the ore of Nictaux in the western part of Nova Scotia.*

The fossils above referred to are derived from the beds immediately containing the iron ore deposits, or from the ore-beds themselves. But in many parts of the district there are rich fossiliferous beds, the relation of which to the iron ores is not so manifest, though they obviously belong to the same great series of deposits. From these beds I have obtained specimens of nearly all the species above catalogued, and some others in addition. The most important of these latter are the following:

Zaphrentis, sp. not determinable.

Meristella didyma, Dalman. A well-known European Upper Silurian species, plentiful in some beds on the East River, but which I have not yet seen from Arisaig.

Lingula sp.

Rhynchonella transversa, Hall (or allied).

R. allied to *R. acutiplicata*, Hall.

R. equiradiata, Hall (or allied).

Orthis multistriata, Hall (or allied).

* *Atrypa emacerata*, Hall.

* *Trematospira Acadica*, Hall.

* *Goniophora consimilis*, Billings.

* *Grammysia Acadica*, Billings.

* *Clidophorus concentricus*, Hall.

* *C. cuneatus*, Hall.

* *Modiolopsis rhomboidea*, Hall.

* *M. sub-nasutus*, Hall.

* *Bucania trilobita*, Hall.

Bellerophon, allied to *B. carinatus*, Sowerby.

* See paper in this Journal, 1879, on 'Recent Papers on the Geology of Nova Scotia.'

Platyceras, allied to *P. pyramidatum*, Hall.

* *Orthoceras exornatum*, Dawson.

O. Pictoense, n. s. (see infra).

O. elegantulum, Dawson.

* *Beyrichia pustulosa*, Hall.

Acidaspis, a small species allied to *A. tuberculata* of Hall
(see infra.)

Illænus.—pygidium.

In the second edition of *Acadian Geology*, 1868, the author published a list of fossils, including many of the more characteristic species above-named, and summed up his conclusion as to their age, as follows: "On the whole I regard the beds seen on the East River of Pictou as belonging to the same line of outcrop with the Arisaig series; but as probably containing in addition to the Upper member of that series beds somewhat higher in position." The fossils more recently collected so far modify this conclusion that I cannot affirm the existence of beds upward as far as the Oriskany, but must be content to regard the highest fossiliferous beds of the East River Silurian as about the horizon of the highest of those seen at Arisaig.

It still remains to inquire as to beds older than the Upper and Middle Arisaig series. As to these great caution is necessary, owing to the paucity of fossils, and to the liability to confound the Upper Silurian rocks with those of the Cobequid group.

Coming up in the anticlinals, and along the flanks of the masses of older rock, there are beds of conglomerate, brown and white quartzite and hard slates, which seem to underlie the fossiliferous beds holding the iron ores, and may represent lower members of the Upper Silurian series. In these beds vermicular markings, perhaps fucoidal and perhaps burrows of annelids, occur near Cameron's brook, and in the same beds are fragments of *Lingula*. I have little doubt that these beds are lower than those holding the iron ores, though probably not below the base of the Upper Silurian. On McLellan's Brook, Mr. Fraser has found beds holding casts of *Zaphrentis*, which may not improbably be older than the Lower Helderberg. The tail of *Illænus* referred to above was found in a small ore-bed on the Fraser (Saddler) location, and which I believe to be not improbably lower than the great beds of Hematite. These are the only fossils known to me at present, which indicate a horizon older than the Middle Arisaig. There are, however, great masses of

older rock which have afforded no fossils, and which probably underlie those just referred to and may be Lower Silurian beds tending downward to the Cobequid series and connected with it.

Rocks of this character are well developed in the basin of Lake Murdoch, where, according to Mr. Gilpin, they are cut off from the Blanchard ore-series by a fault on the southern side. They are traceable to the eastward, apparently underlying the beds associated with the "Webster" ore-bed, and are well seen still further to the eastward on the upper waters of the French River. These beds differ considerably in mineral character from any others in the district, though resembling in this respect rocks seen at the Blue Mountain, near Eden Lake, and on the East Branch of the St. Mary's River. They contain thick beds of Nacreous or Hydro-mica slates, coarse slates, sometimes having a conglomerated or brecciated appearance, green chloritic or epidotic rocks, quartzite and agglomerate, and felsitic rocks. They have afforded no fossils, and appear to me to be quite distinct from the Upper Silurian formation. In the meantime they may be connected with the Cobequid series, with the typical rocks of which series they are certainly closely associated farther to the eastward.

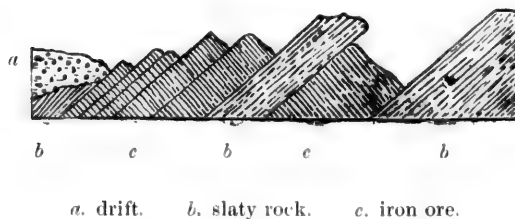
One of the marked features of the Upper Silurian in the district in question is the great development of bedded red hematite, and of rocks more or less impregnated with this ore. With reference to its origin, this ore is evidently a marine deposit, and formed under conditions sufficiently favorable to marine life to enable it to contain many shells of Brachiopods and remains of other animals. It is evidently a chemical deposit or precipitate, and often assumes an oolitic structure. In the coarser or more impure beds the little concretions of oxide of iron often surround grains of sand, and the ore passes into a ferruginous sandstone. The following section taken from a MS. Report of Dr. G. M. Dawson shows the great development of the lower bed in one of its exposures. These deposits of iron ore apparently began locally in an early part of the Upper Silurian period, and were continued into the Lower Helderberg period, while in the western part of Nova Scotia, in the Nietaux district, we have evidence of their continuance into the Oriskany age.

Another marked feature of these deposits is the absence of any representative of the great Niagara limestone, and the consequent passage upward of Clinton deposits into those of Lower Helder-

berg age. This absence of the Niagara limestone is general in Nova Scotia, and along the Atlantic margin of North America. Farther West, in Northern New Brunswick, and in Gaspé, massive limestones appear, but they attain their greatest development in the interior plateau south of the great lakes.

With reference to the dates and disturbances of these deposits, it may be affirmed that there was much volcanic action at the time of the deposition of the Cobequid series; that this series experienced no little disturbance and alteration before the Upper Silurian rocks were laid down; that the latter were subsequently much folded and fractured before the Carboniferous Period, and that since that period there has been sufficient movement to cause the carboniferous rocks to be locally highly inclined and faulted. In the trappean beds, interstratified with the Lower Carboniferous conglomerates of the coast to the eastward, there is evidence of the continuance of igneous action up to that time. As to the age of the iron deposits, the formation of the great veins of specular iron and ankerite was probably contemporaneous with the earliest disturbances of the Cobequid series, and previous to the Lower Helderberg age. The great interstratified beds of Hematite are undoubtedly of the latter age, unless the lowest bed should be regarded as between this and the Clinton. The veins of Limonite, mixed with oxide of manganese, are later than the Lower Carboniferous, and constitute here as in the Cobequids a secondary product of the decomposition of the carbonate of iron contained in the ankerite and spathic iron of the Cobequid series.

IRON ORE BED. WEBSTER LOCATION.



NOTES ON FOSSILS.

A few of the species observed are new, and concerning others new facts were brought out in the examinations made. The more important of these points are referred to below.

Chaetetes or *Stenopora* and *Cladopora*.—Two branching corals referable to these genera are very abundant in the East River beds, and the former also occurs plentifully at Arisaig. The former is a coral of the family *Chaetetidae*, very closely resembling *S. fibrosa*, but the specimens are not in such a condition as to permit a close comparison. The latter is found only in the state of casts, and is a large-celled species resembling *C. fibrosa* of Hall.

Stricklandinia Billingsiana, n. s.

This is a large shell, 6 centims. in breadth and 4 in length, with a pointed beak and the sides spreading at an angle of about 120° to the broadly rounded lateral corners, which are united by a nearly straight margin. The surface presents unequal lines of growth, and in the middle of the dorsal valve is a low flat ridge with a slight furrow in the centre. The ventral valve has a corresponding flat sulcus. This shell is closely allied to *L. Davidsoni*, Billings, from the Upper Silurian of Gaspé, but is much broader in form.

Strophomena Gilpini, n. s.

Shell, when full grown, nearly an inch in diameter; length and breadth nearly equal; hinge line equal to breadth; valves little elevated; hinge area narrow. Surface marked with numerous fine radiating elevated lines, between which others are introduced as they diverge from the beak. When the surface is well preserved microscopic concentric striae are seen to cross the radiating lines, and when the outer surface is removed the structure of the shell appears punctate. Muscular impressions oval, elongate and narrow. This shell is very abundant near the Sutherland River ore-bed. It appears to differ from any described American species, but in general form and the style of the muscular impressions resembles *S. ornatella* of Salter from the Upper Ludlow of Britain, though it has finer and sharper superficial sculpture.

Rhynchonella, sp.

In the upper bed of iron ore one of the most frequent shells is a simply ribbed *Rhynchonella*, somewhat resembling *Rh. vellicata* of Hall, but too much distorted and too imperfectly preserved to enable it to be determined with certainty.

Discina, sp.

A small elevated smooth *Discina*, marked only with very delicate lines of growth and near in form to the more elevated varieties of *D. oblongata*, Portlock, from the Middle Silurian of England.

Megambonia cancellata, Hall.

Perfect specimens of this beautiful little shell show that the right valve is flatter than the left, and destitute of the cancellated markings, having only concentric lines. When the valves are closed the basal sulcus has very much the aspect of a byssal aperture. These characters would ally this shell with *Aviculida* rather than with *Arcada*.

Avicula lamellosa, n. s.

Hinge line somewhat longer than the breadth of the shell, and about equal to its length. Left valve tumid, right valve less so, umbones appressed, base broadly rounded, anterior wing short, but decidedly separated from the body of the shell, posterior wing much larger. Surface smooth, but ornamented with concentric thin raised lamellæ, which are continuous over the wings and body, and are elegantly waved, becoming distant from each other on the lower side. Largest specimen 3 centim. long, 3.5 broad. At first sight this species resembles *A. equilatera* of Hall, but is quite distinct in form and markings.

Avicula, sp.

A single left valve of a well-characterised species with the anterior wing nearly as broad as the posterior, and both flat and smooth, or with microscopic concentric lines on the posterior one. Body of the shell with about 15 radiating ribs, crossed by obscure concentric ridges. I had at first regarded this shell as a variety of *A. Honeymani* of Hall, but the anterior wing, when exposed, showed it to be altogether different. I find it difficult to distinguish the last-named species from *A. mucronata* of Hall, as some specimens show radiating striæ on the posterior wing, and otherwise approach to that species.

Pteronitella curta, Billings.

More perfect specimens of this shell enable me to add to Mr. Billings'* description, that the left valve is considerably more convex than the right, and ornamented with concentric, crowded, raised lamellæ. There are two muscular impressions, the anterior small, oval and near the beak, the posterior large and round.

Murchisonia, sp.

In addition to *M. Arisaigensis* and *M. acicula*, which are common on the East River, there is a third species, much less elongated than the former, and with a single revolving band in the middle of the body whorl. The specimens are not very perfect.

Holopea, sp.

A species not distinguishable from *H. sub-conica* of Hall from the L. Helderberg.

Platyceras, sp.

A small but beautifully perfect specimen of a conical and somewhat pyramidal *Platyceras*, with slight plications on one side. It is not distinguishable from young shells of *P. pyramidatum* of Hall from the Lower Helderberg; and is the only shell of this type I have seen in Nova Scotia.

Orthoceras Pictoense, n. s.

Transverse section oval, perhaps partly a result of pressure. Chambers narrow, 8 in an inch in a specimen 1.5 inch in greatest diameter. Shell scarcely tapering in five inches. Surface when perfectly preserved with delicate longitudinal striæ. Siphuncle not well seen but apparently inflated in the chambers. This is seemingly a representative in our Upper Silurian of *O. bullatum* of England.

Orthoceras (allied to *O. Ibez*).

This species has long been known to me from Arisaig, and I have specimens also from the East River, but not sufficient to make absolutely certain its identity or difference.

* Palæozoic Fossils of Canada.

Ortoceras, sp.

Two species of this genus occur in the East River collections. One is not distinguishable from the *C. subrectum* of Hall (L. Held.) The second is flattened laterally, distinctly bent, the septa one-third centim. distant, in a specimen one centim. in diameter.

Cornulites.

Shells of this species are very abundant in the East River beds. Hall referred the Arisaig specimens to his species *C. flexuosus*; but from their more slender form named them variety *gracilis*. At the East River the majority of the specimens are of the Arisaig type, but some more robust. There are however others more slender than any found at Arisaig. Specimens 1.3 centimetre in length are only 1 millimetre in breadth at the large end, so that from their slenderness they might be mistaken for *Tentaculites*, though the annulations are those of *Cornulites*. But for the apparent connecting forms, these slender specimens might be regarded as types of a distinct species.

Trilobites.

There appear to occur at the East River no less than three species of *Homalonotus*. The most common is *H. Dawsoni*, Hall, and the others are known to me only by fragments. One has much more numerous annulations on the pygidium than that above named, the other has a nearly smooth pygidium, with about twelve very flat annulations on the axis, and resembling that of *H. vanuxemii*, Hall, from the Lower Helderberg. The East River collections also add an *Acidaspis* to the Upper Silurian fauna of Nova Scotia; but the single specimen found is unfortunately too imperfect for description.

NOTE.—For information as to the economic geology of this district, I may refer to "Acadian Geology," and to a valuable Report on the "Mines and Mineral Lands of Nova Scotia," by E. Gilpin, A.M., F.G.S. (Halifax, 1880.)

